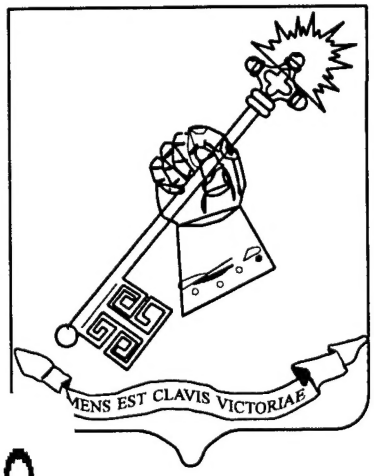
SIMWAR 2010: THE NEED FOR SIMULATIONS IN THE WAR GAMING AND REHEARSAL PROCESS

A Monograph
By
Major Charles G. Heiden
Armor



School of Advanced Military Studies
United States Army Command and General Staff College
Fort Leavenworth, Kansas

First Term AY 95-96

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE

3. REPORT TYPE AND DATES COVERED
MONOGRAPH

4. TITLE AND SUBTITLE
SIMWAR 2010: THE NEED FOR SIMULATIONS IN THE WAR GAMING AND REHEARSAL PROCESS

5. FUNDING NUMBERS

6. AUTHOR(S)
MAJOR CHARLES G. HEIDEN
ARMOR U.S. ARMY

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
School of Advanced Military Studies
Command and General Staff College
Fort Leavenworth, Kansas 66027

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Command and General Staff College
Fort Leavenworth, Kansas 66027

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE:
DISTRIBUTION UNLIMITED.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
SEE ATTACHED

14. SUBJECT TERMS

15. NUMBER OF PAGES
46

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNLIMITED

SCHOOL OF ADVANCED MILITARY STUDIES

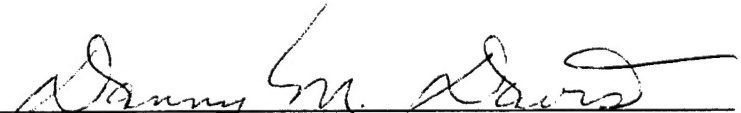
MONOGRAPH APPROVAL

Major Charles G. Heiden

Title of Monograph: SIMWAR 2010: The Need for Simulations in the War Gaming and Rehearsal Process

Approved by:

LTC Charles O. Hammond, MS, MMAS — Monograph Director



COL Danny M. Davis, MA, MMAS — Director, School of Advanced Military Studies

Philip J. Brookes, Ph.D. — Director, Graduate Degree Program

Accepted this 14th day of December 1995

ABSTRACT

SIMWAR 2010: THE NEED FOR SIMULATIONS IN THE WAR GAMING AND REHEARSAL PROCESS by MAJ Charles G. Heiden, USA, 46 pages.

This monograph examines near term and improved means for combat preparations built from simulations used in the Close Combat Tactical Trainer (CCTT, formerly known as SIMNET (Simulation Network)) and the current JANUS/BBS (Brigade Battle Simulation) simulations. Application of additional new simulations can be directed to war gaming and rehearsals.

The monograph will look at war gaming, rehearsals and simulations in three ways. First, this monograph examines war game and rehearsal doctrine at the tactical level of war. The types of war games and rehearsals, and their products, will be examined. Second, the monograph reviews the use of computer simulations for training. The use of current simulations by units to train specific audiences and a discussion of near term developments to link separate simulations is included. Third, this monograph proposes an integrated follow-on system to current training simulations as a war game and rehearsal simulation system. Improvements for units come through simulations and the cybernetic interface to gain time, speed in decision making, and virtual combat experience.

In the application of computer technology to warfare, the U.S. Army stands on the brink of changing the way a unit prepares for battle. Computerized simulations can revolutionize the war game and rehearsal process. Implied in this revolution is the probable merging of these currently distinct activities. As information age warfare evolves from a collection of concepts to firm procedures and equipment, preparation and warfighting must also evolve. New technology requires commanders to think and act in ways that get better results from the new systems.

With a full appreciation of the simulation advantages, unit commanders gain a better aid in plan development, course of action analysis, situational awareness and integration of combat functions to destroy the enemy. The Army must aggressively pursue the use of simulations and their application in the military decision making process. By possessing and using information age technology, the Army gains significant advantages in preparing for combat operations.

TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION

The US Army Chief of Staff defined a critical challenge for the Army to remain trained and ready during the creation of Force XXI information age systems.[1] Army professional literature is starting to recognize this challenge. "In a smaller Army, we cannot afford the luxury of maintaining division-sized units which are designed and trained to accomplish a single mission."[2] To meet the diversified threat faced by the Army and to leverage advances in technology, new ways to prepare for operations become necessary. In an environment with less money for operations and training, a possible method is to add simulations to the war game - rehearsal parts of the planning process.

The Army will continue to face complex and varied contingency missions throughout the world. "Units are responsible for achieving and maintaining readiness for multiple combat missions and military operations other than war."[3] Commanders already train a set of basic skills for these missions. Additional training for missions in different geographic locations, against different possible enemies and in varied environments requires a significant training resource investment. Essential skills, basic to the art of command, may in fact change in the future.

All levels of command must use available resources efficiently and effectively to prepare for combat. "Effective organization of one's knowledge can come about

only with practice and experience."[4] Simulations allow a commander to apply his tactical skills to a specific tactical mission. Adding realism and objectivity while minimizing preconceived notions avoids disastrous errors during planning and boosts combat effectiveness during execution.

As the Army transitions to Force XXI, three assumptions, among many, come forward. First, training and operating costs will continue to rise. Second, the use of automation and computers will become more prevalent. Third, while field training continues for the future, simulation use becomes more important to pre-combat training.[5] The challenge for the U.S. Army during this transition is to focus cybernetic technology as an additional combat multiplier.[6]

How can simulation technology improve war gaming and rehearsing for combat operations? This monograph examines near term and improved means for combat preparations built from simulations used in the Close Combat Tactical Trainer (CCTT, formerly known as SIMNET (Simulation Network)) and the current JANUS/BBS (Brigade Battle Simulation) simulations. Application of additional new simulations can be directed to war gaming and rehearsals.

I will look at war gaming, rehearsals and simulations in three ways. First, this monograph examines war game and rehearsal doctrine at the tactical level of war. The types

of war games and rehearsals, and their products, will be examined. Second, the monograph reviews the use of computer simulations for training. The use of current simulations by units to train specific audiences and a discussion of near term developments to link separate simulations is included.

Third, this monograph proposes an integrated follow-on system to current training simulations as a war game and rehearsal simulation system. Improvements for units come through simulations and the cybernetic interface to gain time, speed in decision making, and virtual combat experience.

Finally, the monograph will conclude with some recommendations for how to carry out the simulation plan. The objective is to produce a unit that enters an operation with a thoroughly war gamed and well rehearsed plan of operation. By using simulations to support a combined war game and rehearsal process, a unit entering combat is likely better prepared to defeat an enemy.

CHAPTER TWO

CURRENT WAR GAME AND REHEARSAL DOCTRINE

War gaming's purpose is to refine a course of action to apply combat power against the enemy. It gives an initial look at enemy actions, friendly actions, potential problem areas and the mission end state. Perhaps more than other parts of the planning process, it dramatically shows the commander if he can accomplish the assigned mission. From the results of the war game, a course of action is selected for execution.

"A war game is a disciplined process for visualizing how a battle might unfold."[7] The war game could produce branches, sequels or an entirely new plan. Keeping a war game current to the situation allows it to reduce uncertainty for the commander about his subunits. Constant updating of the war game with the latest information allows the commander a clear view of the disposition and capability of his force. The object of the rehearsal is reinforcement of the scheme of maneuver and support. A commander can focus his efforts to communicating his expected decisions and intentions.[8]

Current US Army doctrine allows tailoring the war game to the amount of time available in the military decision making process. In deliberate planning, normally the staff conducts one war game. This war game confirms the course of action as valid with an acceptable level of mission

accomplishment. With less time, a hasty war game to confirm the plan uses only primary staff or selected staff members. A commander may elect to conduct a personal war game, judge his course of action and have the staff work only to carry out the plan. Some units have added to the methods, using a hasty war game to select only the best two or three courses of action possible. These are checked with the commander, only a single selected course of action then having a full war game conducted.

The war game clarifies the vision of how friendly and enemy action - reaction - counteraction will take place on the battlefield. A written record of the war game, usually the staff's synchronization matrix, provides the basis for writing the operation order. Translated from the matrix are instructions to units that link their actions in time and space. These instructions become the basis for later rehearsals of the unit.

Rehearsals directly imprint the commander's intent on subordinates. As a confirmation of the entire mission given to a unit, it cannot be limited to the maneuver portion of a plan.[9] It must also cover the other combat functions: intelligence, fire support, air defense, mobility - survivability, logistics and battle command. The Army defines six general principles about a rehearsal:

1) Identifies problem areas and omissions.
2) Indicates required contingencies.
3) Determines movement-reaction time.
4) Enhances coordination.

5) Refines the plan.
6) Increases the confidence of subordinate leaders and soldiers.[10]

Ultimately, the rehearsal aims to establish synchronization between the subordinate parts and units involved in the plan.[11]

Commanders must use their judgement in deciding how to conduct a rehearsal. Influencing the commander are: the amount of time before starting; enemy ability to observe, or become aware of, the rehearsal; suitable terrain and daylight.[12] Ideally, commanders try to select terrain that matches the operational terrain closely. Terrain models, maps or sketches are appropriate for some rehearsals. Units with long term stability and well established standard operating procedures and battle drills potentially need less work on small unit drills, thus devoting more time to the higher commander's maneuver.

There are currently seven types of rehearsals used by the US Army. In order of least to most resources and people required, they are: backbrief, radio, map, sketch-map, terrain-model, key-leader and full rehearsal. To quickly differentiate between them, the following list provides a contrast.

Backbrief: A briefing to the higher commander on the subordinate commander's intentions for the mission. This is different from the "Briefback," which is usually done right after an order issue, to show common understanding of intent and mission. The briefback is sometimes called a confirmation brief.

Radio Rehearsal: Only those portions judged by the commander as critical to the mission are run through by key personnel using the radio.

Map Rehearsal: Key personnel use map and overlay to narrate their actions.

Sketch-map Rehearsal: A large drawing is used to portray events with key leaders narrating their actions.

Terrain-model Rehearsal: A constructed scale model of the actual area, ideally overlooking the area, supports subordinate unit actions.

Key-leader Rehearsal: Like ground is used to actually move leaders (representing their units) around and have them execute their unit's actions.

Full Rehearsal: Full unit participation in their vehicles, on like ground, executing their sequential actions for the mission.[13]

Rehearsals produce both tangible and intangible results for the participants. The most significant tangible result is a sequence of events for the mission, both related by expected time and actions or results.[14] This sequence of events is not a strict time schedule. It relates time to actions by friendly or enemy units and the decisions or reactions each produce to support mission accomplishment. By allowing time for subordinates to conduct their rehearsals first, the senior commander can obtain valuable feedback about task accomplishment. Intangible benefits include an increased sense of purpose, direction, motivation and faith in one's plan.[15] For the participants, the rehearsal should leave a clear mental picture of who, what, where and why actions are happening on the battlefield. This internalized knowledge of the combat tasks reinforces the written order and map graphics.[16]

Rehearsals are a vital component of successful mission accomplishment.[17] This is included by implication in the eighth step of troop leading procedures as a commander supervises and refines the execution of a plan. FM 101-5 (Final Draft), addresses the reason for rehearsals so units "gain agility for the force, ensure coordination of events, enhance mutual support."[18]

As a whole, the Army has not addressed linking war gaming and rehearsals to virtual and constructive simulations now used in training. "The requirement for mounted warfare training to be increasingly simulation-based . . . points to the future conduct of battle preparation."[19]

CHAPTER THREE

CURRENT AND FOLLOW-ON SIMULATION TECHNOLOGY

As a whole, the Army is a conservative organization that is often slow to adopt new methods and technology. This has not been the case with computers and other forms of digital technology. In the late 1960's the military adapted computers to help with logistics calculations, then the assembly and processing of intelligence data.[20] When digital computers became smaller and more reliable during the late 1970s and early 1980s, the military adopted them. This time, the integration process was slower.

The speed and applications of the technology overcame the ability of the Army to assimilate it. Programming to simulate equipment or battles began without clear and progressive thinking on what lessons they would teach leaders. Within the Army, there remains some resistance to the use of simulations and the generated results as true to life. For those with a more visionary bent, the application of computers to simulation war games was the next logical step in preparing units for combat.[21] This investment would eventually return higher combat readiness for tactical commanders.

Military simulations have a long history.[22] Primarily, the best use of simulations in the past sought to replicate actual combat. The U.S. Army developed the National Training Center, SIMNET and a variety of computer war games

as realistic simulation tools to prepare units for combat. The National Training Center is a "live" simulation. Soldiers perform their missions on actual vehicles under conditions designed to closely approximate combat. CCTT is a "virtual" simulation where soldiers do many of the same tasks, but view each other and interact through a virtual environment created by computers.[23] Computer war games, such as JANUS and BBS, are a third type of simulation, known as "constructive." Usually, only selected personnel from the unit take part in the exercise, sitting at computer consoles and interacting with icons on a display.[24] Sustaining a high level of proficiency for commanders, staffs, units and soldiers is a primary concern for a force not constantly engaged in combat. Simulations provide the needed practice.

By tying all these types of simulations together, the Army increases the combat readiness of units. The improved combat readiness of these units can produce better results than the Army experienced at Kasserine Pass[25] or with Task Force Smith.[26] The Gulf War in 1991 has become accepted as initial validation of the current training methods. Application of technology to training continues. Availability of the right mix of training aids and simulations is a keystone of the training system chosen.

The Army has concentrated on using open loop simulations, like CCTT, to replicate the battlefield for

small units. Closed loop simulations, essentially with few chances for human interactions, like JANUS replicates processes (i.e., how the staff in a TOC operates and uses battlefield information). Simulations replicating the battlefield as a whole and combining functions and processes are relatively recent. Current simulations, examined next, consider their future utility and direction for war gaming and rehearsals.

The SIMNET has been an extraordinary tool for the Army. Originally begun as a tactical trainer for platoons and companies in the early 1980's, SIMNET grew rapidly. Army Research Institute (ARI) realized this trainer could also begin answering developmental questions on future information technologies and weapon systems.[27] ARI and the Armor School evaluated early conceptual versions of the M1A2 in a facility known as SIMNET-D (Simulations Networking - Developmental) and later as the Mounted Warfare Test Bed.

Devised as a low cost alternative to supplement field training, SIMNET saw extensive use at Fort Knox. Additional sites opened in Germany, Fort Rucker and Fort Benning. Units varied considerably in their acceptance and use of the system.[28] This came from experience with simulations and differing abilities to distinguish between simulation peculiarities and true lessons learned. The evolutionary upgrade of SIMNET is now the Close Combat Tactical Trainer (CCTT).

Currently in testing by the Army, CCTT can expect full production during 1997 and operational in 1998.[29] CCTT more fully integrates all the combat systems, but only to the company level. Battalion level training is a potential upgrade for the future.[30] The Armor School recommends CCTT use for 20 days per year supplementing 23 days per year in actual field exercises.[31] A projected life span of ten to fifteen years will carry CCTT through several upgrades and well into the beginning of the next century.

A prime concern for upgrading the CCTT is networking the simulation to other training simulations. By expanding the training audience, multi-level training of units from platoons through brigades or divisions becomes possible. Integrated training of this type means rehearsing actual combat plans in a combination virtual-constructive environment. Integrating lower level units completely into a higher unit's operational training provides realism for both and saves the time of conducting two separate exercises.

Other computer simulations focus on the commander and his staff. Historically, they are a development of the command post exercises and map board problems used by the U.S. Army since before World War II. JANUS is a constructive computer simulation of this type. While JANUS can replicate actions at a low level, the leadership value for the squad leader directing icons on a screen is limited;

his leadership depends largely on personal interaction. Both the JANUS and BBS, another constructive computer simulation, had separate developments to satisfy different requirements. They have become similar in the latest versions, mainly through the user interfaces. This commonality allows skill transfer between the simulations for the average user.

Using this constructive simulation to exercise commanders and their staffs in tactical planning gives them some realism about reports, control of units and the military decision making process. Totaling up the results as a "win" or a "loss" is more difficult than for the CCTT. Engagements in the constructive simulation are highly dependent on the rules and probabilities that govern detection, weapon firing and hit/kill determination.[32] An entirely automated simulation eliminates the human interaction that direct combat units depend on. Simulations without human interaction do not include Clausewitz's concepts of "friction" and "fog of war."[33] The emotional factors governing soldiers do not enter the probabilities governing weapon firing and hit/kill determination.

In the conduct of a scenario and battle performed as a supporting experiment, a task force battle took place at night. Many questions about lessons learned from the experience transference come about. Would the enemy have been 100 percent alert all night, perfectly observing their

sectors? Would the friendly force have operated at peak efficiency without a leading decision to change the rest cycle of the unit for a night operation? These types of questions require answers separate from the simulation, but still factor into a commander's concept and plan.

The SPECTRUM simulation is a development of BBS designed to train operations other than war (OOTW).[34] While it can portray all the conditions and systems of BBS, it contains adjustable software modules. These software routines allow additional forces to be placed on the battlefield, interacting with traditional red, blue and white (neutrals or civilians) forces. Other force icons make commanders' decisions complex.

The WARSIM 2000 simulation is a replacement for the BBS, CBS (Corps Battle Simulation) and TACSIM (a tactical intelligence simulation) systems that integrate various command and staff levels to a single system.[35] Integration of WARSIM 2000 with CCTT and the automated battle command systems (ABCS)[36] should be a major concern.

Live simulations remain in the evolutionary nature of CTCs. These require the fielding of engagement systems that replicate effects of actual systems engaged in combat. Human factors influence the results at the CTCs more than anything else. Fear and task failures in the observed and controlled environment become immediately and forcefully apparent through the rotational training. These live

simulations will remain staples of Army combat preparation well into the next century.

The training of soldiers, crews and units has improved from simulations. Commanders and staffs remain limited in their ability to refine plans to specific contingencies. Computers and sophisticated software make the repetition of war games and rehearsals much simpler. Fed by a historical database of the enemy, updated with the latest available intelligence, current terrain and other factors, the simulation builds greater realism and credibility.[37]

General experience at the Combat Training Centers recognizes the need for an uncooperative enemy force during a war game of a plan. Extensive computer power could provide an artificially intelligent, uncooperative opponent in the form of Synthetic Forces (SF). Artificial intelligence means "(A) computer . . . able to do more than calculate; it must (learn and) 'think.' It must be able to accumulate knowledge and apply it to solve new problems."[38] While still algorithmic based for decisions, this capability is a starting tool in the short term. Computer software would provide a doctrinally correct opponent geared to intelligence gathered from academic schools, recent combat experience, monitored training exercises and known background of enemy commanders.

Applications of synthetic forces to military war gaming in early versions would be limited and may require

augmentation through a networked, live decision maker from outside the unit. This injection of the "fog of war" is to give the unit leaders a tough fight during the war gaming of a plan. A proficient enemy commander removed from the unit allows the staff to function normally. As an example, the S-2 performs as the intelligence officer instead of the enemy commander. Staff integration at this early stage allows an expert system to form and begin functioning. Unfortunately, this requires an extensive reconnaissance and surveillance effort of potential enemies to build a credible database. A precedent has been set with chess programs that can play at a better than average skill level. Transferring the concepts of expertly fighting chess pieces and mechanized units according to a set of rules does not appear overwhelming.[39] This single area requires the most work in the development of an expert system to aid commanders and their staffs.

Credible battlefield results from a simulation depend heavily on previous experience of the commanders and their staffs. These "immersive factors" are critical since they register the strong belief of being somewhere else through virtual reality.[40] By constructing the simulation interface for a rehearsal or war game to match the ABCS, commanders gain experience and confidence, developing intuition about their coming engagement.[41] As belief in the simulation progresses, from a computer screen to a crewed simulator

that replicates controls, motion, sight and sound, immersive factors lend credence to battle results. Immersive factors such as the accurate replications of terrain also add realism and believability to the rehearsal or war game. The simulations can have real consequences, mainly for those in a closed virtual environment as dismounted infantry or special warfare units experience. These types of units depend on unfiltered human senses to provide experience, the vehicle crew can fight entirely enclosed. This "simulator sickness," described as the result of disorientation from visual signals and bodily attitude does not effect everyone.[42] This may have implications for mission rehearsals as SIMNET follow-ons become more realistic for vehicle crews and dismounted soldiers.

The final link to generating useful, realistic data with which units can conduct rehearsals is the terrain database. Reconnaissance satellite data is available for the production of digitized maps, either for hard copy or digitized terrain bases in computers.[43] With the addition of Global Positioning System (GPS) receivers in units, accurate routes, positions and even line of sights for engagement areas are plottable ahead of time. As units occupy the positions, some local conditions and GPS error adjustments become necessary. The rehearsal and plotting of a defensive engagement area through accurate terrain databases and line of sight plotting will cut down on total

defensive preparation time for a unit. In the offense, the ability to locate intervisibility lines in the terrain, predict likely enemy engagement areas or defensive positions will assist the maneuver and targeting process for commanders. Detailed rehearsals, with current enemy unit locations, provide direct links to predeployment war games.[44]

A new simulation system to leverage an advantage over future enemies requires an extensive database to support it. Intelligence collection, a vital component of information age warfare already, provides the foundation for simulations as war gaming or rehearsal tools. Digitized terrain for anywhere in the world allows much better planning and initial locating of units. Synthetic opposing forces, built around a model of technical and tactical capabilities or tendencies, will require unit commanders to look at realistic courses of action much earlier in the military decision making process. This does not dispose of the requirement for a manned opposing force in virtual or constructive simulations. But as a local planning, war gaming and rehearsal tool SF will suffice to test a plan. Linked to a training center or intelligence analysis center by satellite, a manned opposing force would obviously fight much more intensively.[45]

Low cost is a requirement for a war game system, software, hardware and support systems from outside the

unit. The current path of simulations developers, as shown by CCTT and SPECTRUM, are to improve on the current family. There is not a battalion to division simulation envisaged for the unit to own and take to war. This idea leads to requiring transportability and ruggedness in a system for use at home station, during deployment and in combat.

For the simulation to be effective, it must meet extensive cross-disciplinary support requirements. Units will need information requests from all the intelligence collection assets available, current files need updating, CD-ROM or floppy disks produced in a very short time and then distributed to the users. This effort will be continuous. It aims at refining the simulation to provide a short term war gaming and rehearsal tool and a long term predictive aid for commanders and staffs.

Simulations are currently an underutilized assistant to the operations planning and orders sequence in troop leading. As the staff develops courses of action, the standard sketch evolves as a video playback of action, reaction and counteraction by the friendly and enemy forces. This means during the briefing of subordinates, commanders could provide a video overview play of the battle.[46]

The simulation based rehearsal is interactive. The commander can replay the battle and adjust his actions in time and space to produce his intent's desired end state. With the approaching high speed digital communications

systems, transmission of full motion video to subordinate units for a common understanding of orders and their requirements becomes reality.

Near term projected technology, added to the cybernetic systems available now and their developmental follow-ons points to a new type of war game - rehearsal linkage based on computer simulation and digital communications.[47] Much of the technology in battle command vehicles and the ABCS provides a start in this direction.

If time, enemy contact or daylight prevents unit leaders from attending a meeting, an interactive video conference provides a possible viable substitute. In some situations, units could receive orders and fight without physical contact with a higher headquarters for an extended period. Only the most basic recognition has begun on the problem of relating contingency plans, war games, rehearsals and simulations.

CHAPTER FOUR

THE MERGING WAR GAME AND REHEARSAL

Application of available technology to improve common procedures remains uneven across the Army, but improving. Potential gains in a better orders process remains nearly untapped as leverage against potential enemies. The potentials for a better war game and rehearsal portion of planning will prove a significant advantage to combat units.

Cybernetic aids will affect the more traditional means of conducting war gaming and rehearsals in the decision making process. Cybernetic aids cannot replace the separate products developed as part of the process but the Army cannot dismiss the capability available on the commercial market in war game simulations. This application of cybernetics brings additional information and aid to a commander.

Field commanders require sophisticated and detailed information to support the needs of a useful simulation. This gives unit commanders and staffs the ability to enter battle better prepared with branches and sequels to the base plan. Once integrated into the process, cybernetic aids have application for war gaming the courses of action developed. This can provide earlier elimination of unsuitable, unacceptable or unfeasible courses of action. Later detailed interactive war gaming and rehearsing of a

plan can allow a higher level of synchronization and integration of combat power against the enemy.

As information age command and control systems become more common in the Army, cybernetic decision making aids will also emerge. Already fielded and used by units, the All Source Analysis System (ASAS) is augmenting division intelligence sections. By automating the collection and pairing of reports by time, location or sensor, a unit gains a net reduction in battlefield uncertainty. With leaders devising a plan and fighting it in a virtual or constructive simulation several times, uncertainty is also reduced. Units then enter the battle with more experience and better preparation. Current ideas of war gaming and rehearsing as separate activities should begin to merge. The two activities become nearly simultaneous with current information constantly fed to the simulation.

Requirements for useful planning tools include simplicity, portability and speed. The basic level of computer war game for units must incorporate these ideals. Use of a Windows-like interface gains a familiar background shell for the average user. Notebook computers offer the same or better computing power and multimedia options as desktop computer systems. Notebook computers can also be hooked together through a local area network (LAN) to provide multiple players in a simulation.[48] The simulation software should derive from the current style of BBS and/or

SPECTRUM. It will require updating as changes occur in threat tactical doctrine and capabilities. Update modules that install themselves offer a quick and familiar method of tailoring the simulated battlefield for a unit.[49]

An ability to network several machines together adds utility for commanders and staffs. Obviously, the current uses of current and near term battle command systems such as MCS, Enhanced Position Location Reporting System (EPLRS) and IVIS form a basis for data transfer. These systems were built several years ago and are much slower than current civilian counterparts. Connections between simulations, like those of an automated battle command system must work in near real time. Long data transmissions will allow location of the sender by enemy direction finding as surely as long voice radio transmissions. Upgradeable software and hardware allow the Army to take advantage of civilian developments. To work actively with other simulations and the tactical control system, army field simulation computers should take advantage of radio, cellular phone, MSE, satellite relay, hardwired LAN/WAN and eventually line-of-sight communications lasers. Ultimately, the method of communication with other systems must be transparent to the computer and user. Dedicated digital communications nets within the tactical communications network, with required encryption and protocols are basic requirements for the simulation tool. Cybernetic war games and rehearsals, using

even available communications systems, can reduce the transit and vulnerability of commanders moving around on the battlefield.

Terrain analysis is critical to accurate and useful planning, war gaming and rehearsing. The use of digitized terrain maps has already begun. CCTT and JANUS portray terrain databases of the NTC for training, war gaming and rehearsal use.[50] Digitizing the world as a map is a large order. Potential deployment missions for units cover the world in the force projection Army envisioned for the near term future. Defense Mapping Agency's ranking of areas to be digitized based on probable deployment will focus this effort.[51] Once accomplished, earth orbiting satellites provide the updating required by units after alert, or as required to keep planning current.

While future developments will improve the resolution of terrain, even the best digitized terrain map requires a trained NCO or officer to stand on the actual ground. Terrain resolutions of extremely fine magnitude will be very large and unwieldy files. A person must evaluate the ground and select exact locations for individual vehicles and personnel at the platoon and company level. As units move through the terrain, collation of updates on the ground goes to division through the ABCS system. A regular update distribution of the terrain database can be done through the

same system to other concerned units, both higher, lower and laterally.

Civilian industry is already incorporating many militarily useful features in their off the shelf commercial products. Commercial gaming companies have already developed military simulations based on World War II, Vietnam and Desert Storm. These simulations play land, air and sea combat from squad to army level[52]. While these provide a crude level of simulation and player networking, they provide examples of possibilities. A computer chess program, at a very high level of sophistication, has earned chess titles and even beaten human opponents.[53] Of course these programs begin as a reflection of the programmer. In constructing a model enemy commander, programmers and intelligence officers work together to avoid an intelligence mirroring of U.S. attitudes or beliefs about the enemy. Enemy commander profiles built as modular sub-programs to the simulation system provides the most versatility.[54] At the most basic level, the opposing force in a war game follows enemy doctrine with variation to account for terrain and known friendly vulnerabilities. This enemy would attack or defend with multiple battles producing roughly the same enemy responses. To provide training or basic concepts to the players, the ability to have synthetic forces play a doctrinally constrained or unconstrained enemy might be an optional switch. The normal mode of operation requires the

synthetic forces to learn from the opponent and make decisions based on previous runs of a scenario.

Optional menus could also allow unit commanders to fight simulated graduates of any of the major advanced military academies or colleges around the world. Graduates of CGSC, Frunze Academy, Sandhurst or others, can portray an adaption of tactical/operational teachings to a specific organization. This profile would require tempering through the experiences of an officer from a specific area of the world. For any of these automated opponents, the unit intelligence officer becomes responsible for entering the initial conditions and locations for units. Following this, the intelligence officer returns to his normal role in the staff and does not have to play the current dual role of enemy commander and friendly collector for the rehearsal or war game.

At the most sophisticated level, classified data would be available on enemy capabilities and intentions, actual enemy commander profiles and recently observed training exercises. The level of ability for the artificial intelligence necessarily increases to the same level of sophistication allowed to the friendly commander. Additional modules for this program introduce factors of friction and uncertainty. A set of probabilities covering weather, equipment and unit experience, working on both

sides, affects abilities to detect, engage, destroy and move units.

Classified profiles of enemy commanders for use during deployment or real war planning, require tailoring to the expected enemy commanders the unit will face. The database built would include education before joining the military, basic and advanced schooling, combat experiences and other schooling. The object is to create a likeness of how the enemy commander will fight. Simultaneously it gives the commander, intelligence and operations officers, a glimpse of what to expect for the initial battle contact.

Logistics for the information age will require detailed planning. The sheer volume of information, the need to keep it current and move it to many units, will require new methods of transmitting data in units. Transmission of secure information to the division level from national collection centers is currently available.[55] Once within the division, distribution becomes a different matter. A fully installed ABCS system will allow transmission of data within the division over a wide area network. The volume of information sent could tie up the communication systems for a prohibitive amount of time. To avoid this, manual distribution by courier of CD-ROMs or floppy disks to the units becomes an alternative for large updates. Another possibility could provide parallel voice and data channels

for information movement. Updates to this initial issue will come through broadcast transmissions.

At the divisional data receiver, or possibly the corps, would be the necessary machines to quickly mass produce CD-ROMs or disks. As a central point of communications, the division is the lowest level capable of handling the task of mass production or transmission of large volumes of data. Centralized processing and the use of read-only memory insure the stability and uniformity of the product during distribution to subordinate units. Storage and control of classified CDs for actual war plans are essentially the same as currently done, though physical space is smaller. Even the unclassified version of the war gaming simulation tool would require some level of control to prevent use of the modeling programming against friendly units.

As an addition to the current fixed site simulation capabilities, information age units should the ability to carry a war gaming tool with them. A unit ABCS needs to have a usable war gaming system. There is also a need for a system and methods not tied to large power requirements, vehicles or traditional methods of operation. Power projection units do not have the luxury of waiting to arrive on the ground. Their valuable transit time needs to equate to war gaming and rehearsal time.

After discussing the current trends and needs of information age units, an evaluation must be drawn against

the current state of war gaming and rehearsals. Any addition or change to the rehearsal thought process and system must meet or exceed the current usefulness. A cybernetic rehearsal would not replace any of the current methods used by company-sized and lower units. Live simulation is the most practical method for the individual soldier, crew/squad, platoon and company. These are the levels with a geographically concentrated location and a relatively single purpose. Company and subordinate leaders gain more clarity of intent and unity of effort from one of the seven current forms of rehearsing combat actions.

Units larger than company, particularly with all combat functions, can benefit from cybernetic rehearsals. Battalion and superior units become the level where round trip travel time is an additional factor in preparing for a mission. Using a cybernetic war game to portray the enemy and realistic battlefield conditions, the order issued to units can allow for more major tasks in the battle.

The cybernetic simulation has the potential to run interactively with the participating leaders. This single act will point out problem areas, omissions and required contingencies from the subordinate's interpretation of the commander's plan. Using the simulation to provide realistic movement times, even run at a faster than real time speed, will show who is in position and who is not. Coordination of the plan and refinement can take place in a very similar

fashion to the current method. Problem areas stop the process temporarily, but the simulation will not allow a subordinate to arbitrarily adjust his movement or location without other consequences. As a rehearsal insures coordination of the final plans of subordinates, the higher commander's simulation may have modifications by the better resolution of the lower units. With an impartial opposing force the subordinate's confidence in the plan becomes higher than by previous methods.[56]

While commanders now consider positioning of units and integrating a plan by transferring graphic overlays accurately, the cybernetic war game can provide reassurance. The plan must be available in the networked computer system, but each subordinate will see how the pieces fit together. There is no requirement to consider travel time, enemy action while the leaders are absent, the availability of suitable ground or the time of day. Cybernetic rehearsals can be done in real time from subordinate's current locations. Using secure data and voice links, commanders, staffs and supporting units reduce their dependency on physical presence, accurately copied overlays or vehicular travel. Battle, as envisioned by the commanders, can still portray a disciplined process in a simulation on an automated command and control system.[57]

Properly integrated, the computer war game can produce a display of time phase lines or time/event occurrences.

Subordinate commanders can show their execution plan graphically and interactively. This refinement of the higher commander's plan allows more detailed synchronization of adjacent and supporting units' fire on the enemy. Detailed knowledge of the enemy equipment, positions and terrain applied against the best analysis of enemy weakness and friendly strength should bolster the confidence of all participants. Being able to see the results at the rehearsal and tag events with action cues for a commander reinforces the purpose, direction and motivation subordinates need from their commander. Speed and flexibility for subordinates comes from their improved awareness of the commander's intent.[58] This represents a new advantage for distributing commander's intent to lower staffs and subordinate commanders within a unit.

Referring to the FM 101-5, page 4-25, points on what leaders should get from a rehearsal, the interactive simulation covers the first four easily. Refinements to the unit plan, based on subordinate units plans remain up to the judgement of the commander. What the cybernetic assisted rehearsal will show is the relation of time, distance, ranges, line of sight and some possible results of an engagement; much better than any of the current methods. A cybernetic rehearsal with a positive outcome for the unit will boost the confidence that the planners and leaders have planned well.

Something is missing in the application of computer simulation to information warfare. It is the full integration of training simulations with combat requirements to gain an advantage for combat. The next step is for the commander to fully use a computer's potential as his decision making assistant. By adding the best simulation of the enemy to the envisioned information systems, the Army can change the method of preparing for battle. Taking full advantage of information processing, communications and new methods of problem solving allows commanders a hidden combat multiplier; the "virtual" ability to get inside an enemy commander's mind and his decision cycle.

CHAPTER FIVE

CONCLUSION

In the application of computer technology to warfare, the U.S. Army stands on the brink of changing the way a unit prepares for battle. Computerized simulations can revolutionize the war game and rehearsal process. Implied in this revolution is the probable merging of these currently distinct activities.

As information age warfare evolves from a collection of concepts to firm procedures and equipment, preparation and warfighting must also evolve. New technology requires commanders to think and act in ways that get better results from the new systems. The large scale computer simulations of today are upgrades of systems that were state of the art ten or more years ago. With the arrival of MCS, IVIS, EPLRS and PHOENIX, the Army began experiments with computerized command and control systems. System developers concentrated, for the most part, on how to do what we do now, only better. The aim of applying computer war gaming to plan development in war game methods and rehearsal methods remains fertile ground. For these reasons, the FM 101-5 products of a war game or rehearsal may not be the best criteria to judge a cybernetic war game and rehearsal system. If the unit merely uses computers for the same war game and rehearsal methods, then the addition has merely improved an established system. Units need to apply

technology to the entire military decision making process. This monograph focused on simulations in war gaming and rehearsals as a tool in defeating an enemy. Although simulations can play a larger role in aiding commanders, the education and experience of leaders remain primary in war fighting.

Confidence can be built on computer uses in war during peace time training. Application of new methods takes on a larger role when limited in training for operations. In the near future live, virtual and constructive simulated experience must combine to give combat like experience.

Future applications of automation in war gaming and rehearsal methods require further investigation. Investigation of the war gaming skills necessary for leaders, followed by when and where to teach them, remains almost unaddressed in Army literature. This paper has only briefly touched on how the computerized war gaming and rehearsal process changes the actions of unit commanders at the battalion and brigade levels. Could it allow them a refocusing of attention from resourcing a fight to visualizing what will happen during and after the battle? Will the commander's role change from the need to develop intuition about the enemy, provide human contact and interaction with subordinates to defeat the enemy at minimum cost?

Security of the programming code and the update modules for a specific contingency mission represents a considerable challenge. Computer proliferation on the battlefield and long distance networking presents the specter of a functioning system captured by the enemy. The loss of a classified CD-ROM or disk could allow a potential enemy to deliberately change his methods, thus degrading the usefulness of the war game and rehearsing simulations.

A total reliance on automated systems anticipates and may cause the degradation or loss of manual skills. Even the best artificial intelligence program will be unable to predict irrational acts. A subset of this is a commander's refusal to accept trends or predictions by computer analysis. Application of simulations using large volumes of data to provide predictions and assistance represents a serious collection problem. When information age units fight a military force relying on people and leaders without formal military education or training systems, this problem will magnify itself.

With a full appreciation of the simulation advantages, unit commanders gain a better aid in plan development, course of action analysis, situational awareness and integration of combat functions to destroy the enemy. The Army must aggressively pursue the use of simulations and their application in the military decision making process. By possessing and using information age technology, the Army

gains significant advantages in preparing for combat operations.

Additionally, the Army must gather strategic, operational and tactical intelligence to support more realistic combat simulations. Portions of this include the educational system for soldiers to gain an understanding of simulation benefits, differences from real combat and how to exploit them. Other parts include the professional and social interactions between soldiers of other armies, observation of training exercises and combat. Soldiers who have fought the terrain before, rehearsed their actions, understand the enemy and apply combat power with the benefit of virtual or constructive simulations have an advantage over the enemy.

ENDNOTES

1. Hiller, J., Wallace, S., Marcy, S. & Akam, R. "Development of a Force XXI Training Management Strategy." Army RD&A (May-June 1995), p. 10.

2. Halpin, Stanley. "Developing Force XXI Battle Commanders." Army RD&A (May-June 1995), p. 7.

3. Hiller, J., Wallace, S., Marcy, S. & Akam, R. "Development of a Force XXI Training Management Strategy." Army RD&A (May-June 1995), p. 11.

4. Halpin, Stanley. "Developing Force XXI Battle Commanders." Army RD&A (May-June 1995), p. 9.

5. Live simulations mean units participating in a combat training center-like battle. It requires the use of actual equipment and devices to create the effects of battle without actual combat risks. A constructive simulation is a computer war game, normally played without large deployments of soldiers and equipment. Compared to a live simulation, constructives target training unit commanders and their staffs. A virtual simulation uses soldiers crewing simulators in a computer created world designed to simulate, not precisely replicate, combat conditions. Like the combat training center, virtual simulations offer unit actions, mainly for mounted vehicle crews.

6. Webster's Third New International Dictionary defines cybernetics as: "The comparative study of the automatic control system formed by the nervous system and brain and by mechanical - electrical communications systems and devices." The broader definition of cybernetics as any command, control or communications system used in accomplishing a task contains too many imprecisions for use. This paper seeks the integration of man, hardware, software and communications systems to perform old tasks in new ways.

7. FM 101-5 Command and Control for Commanders and Staff (Final Draft). (Aug 1993). p. 4-28.

8. Ibid., p. M-1.

9. Rehearsals. CALL Newsletter No. 91-1 (Apr 1991). p. 2.

10. FM 101-5 Command and Control for Commanders and Staff (Final Draft). (Aug 1993). p. 4-25.

11. Rehearsals. CALL Newsletter No. 91-1 (Apr 1991). p. 17.

12. FM 101-5 Command and Control for Commanders and Staff (Final Draft). (Aug 1993). p. 4-25.

13. Department of the Army, FM 101-5, Command and Control for Commanders and Staff. (Final Draft) (Washington, D.C.: Department of the Army, Aug 1993), p. M-4 to M-9.

14. Rehearsals. CALL Newsletter No. 91-1 (Apr 1991). p. 6.

15. FM 101-5 Command and Control for Commanders and Staff (Final Draft). (Aug 1993). p. M-1 to M-2.

16. Ibid., p. M-2.

17. Department of the Army, FM 101-5, Command and Control for Commanders and Staff. (Final Draft) (Washington, D.C.: Department of the Army, Aug 1993), p. 4-25.

18. Ibid., p. 4-25. Rehearsal attendees are to benefit in six areas: 1) identifying problem areas and omissions; 2) indications of required contingencies; 3) determining movement-reaction times; 4) enhancing coordination; 5) refining the plan; and 6) increasing the confidence of subordinates.

19. Burnside, B., Quinkert, K., Black, B., Maggart, L. "Design of Mounted Warfare Training for Force XXI." Army RD&A (May-June 1995), p. 13.

20. Interview with Major General Charles K. Heiden (Rtd).

21. Jones, Paul L., ed. Simulation Training Management Framework Improved, but Challenges Remain. GAO/NSIAD-93-122 (10 May 1993), p. 8. "Technology achievements in the 1980s permitted the networking of multiple, homogeneous weapon system simulators into an interactive, electronic battlefield where military crews could obtain realistic training on selected tasks."

22. Simulations of war extend back to the drill fields which ingrained formations and actions of the units into the men. Mass maneuvers, such as the series of maneuvers in the southern U.S. before World War II, sought to teach control of large units and prepare for combat. More recently, the U.S. Army has used RealTrain for units and Dunn Kempf to let units rehearse combat tasks. Modern simulations grew from this base and became ARTBASS and the MILES system (as an impartial arbitrator of engagements). The National Training Center, begun in the late 1970s, was an outgrowth of the Air Force Red Flag and Navy Top Gun programs.

23. Jones, Paul L., ed. Simulation Training Management Framework Improved, but Challenges Remain. GAO/NSIAD-93-122 (10 May 1993), p. 11. "In SIMNET, numerous computer-driven simulators (configured around a mockup of the interior on an armored vehicle) are electronically linked to form a common combat arena or battlefield. Each simulator contains high-technology electronics, microcomputer processing, and visual displays with three-dimensional graphics to help operators believe they are in actual combat. . . . SIMNET also incorporates some battlefield participants that are generated by the computer. These participants are called semi-automated forces because a trainer initiates a combat task from a computer work station. . . . Other functions are initiated from computer work stations to depict air and artillery strikes and provide combat service support by dispatching fuel, maintenance, and ammunition trucks when needed."

24. Computer war games such as JANUS, BBS and ARTBASS concentrate on having unit commanders operate the computer terminals that control subunit icons. Higher commanders and their staffs conduct the battle as if actual units were maneuvering. In a brigade sized unit, for example, less than two hundred personnel would be involved in the exercise out of around four thousand.

25. Howe, George F. "The Defense of Kasserine Pass, 19 February," and "The Loss of Kasserine Pass." U.S. Army in World War II, Mediterranean Theater of Operations; Northwest Africa: Seizing the Initiative in the West. (Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1957), p. 447-452 and 453-456, respectively.

26. Appleman, Roy E. "Task Force Smith at Osan." U.S. Army in the Korean War; South to the Naktong, North to the Yalu. (Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1961), p. 65-76.

27. Quinkert, Kathleen & Black, Barbara. "Training for Force XXI Technologies." Army RD&A (Nov-Dec 1994). p. 45.

28. Heiden, Charles. "Integrating SIMNET Into Heavy Task Force Tactical Training." Army Research Institute Research Product 95-01 (October 1994). This paper gives a complete example of how a company or a task force can integrate SIMNET into a comprehensive plan to prepare for a rotation at a combat training center. Many other units the author observed used the SIMNET for specific purposes; i.e., prepare for Tank Table XII at Grafenwohr, with no thought to applying specific MTP tasks to the simulator world.

29. Jones, Paul L., ed. Simulation Training, Management Framework Improved, but Challenges Remain. GAO/NSIAD-93-122 (10 May 1993). p. 2. These dates were confirmed by the CCTT project managers office as still on target.

30. Ibid., p. 32.

31. Ibid., p. 31.

32. Computer simulations are governed by a complex, interacting set of rules which produce an "answer" to line of sight, weapon range, percentage of hit/percentage of kill and protection of the target. The decision to fire or not fire settings come from several variables. Once calculated, the target picture icon is modified as either hit, kill or missed. By varying the precedence, order or value of each rule entirely different results can occur from the same incident.

33. Clausewitz, Carl von. On War. New York: Alfred A. Knopf, Inc. 1993. Book 1, Chapter 7, p. 138-140.

34. Basic description of SPECTRUM taken from the National Simulations Center introduction briefing on BBS, 26 September 1995.

35. Development of WARSIM 2000 taken from the National Simulations Center introduction briefing on BBS, 26 September 1995.

36. Throughout this paper, automated battle command system, ABCS, refers to any computerized system displaying location of friendly and enemy forces and digital message traffic to assist in the command and control of units. Some current systems of this type are: IVIS, PHOENIX, EPLRS and MCS.

37. Barnaby, Frank. The Automated Battlefield. (New York: The Free Press, Macmillan, Inc, 1986). p. 108.

38. Ibid., p. 95.

39. Senge, Peter M. The Fifth Discipline. (New York: Doubleday, 1990), p. 27-54. There is an extensive practical example of feedback loops given in this book. Called the "beer game," it is a classic example of trying to predict an outcome during a period of time with apparently unpredictable feedback. The rehearsal or war game opponent would be computer software that learns based on past experience (initial conditions of past combat or training exercises) and adapts to the friendly commander's actions.

40. Witmer, Bob; Bailey, John & Knerr, Bruce. "Training Dismounted Soldiers in Virtual Environments: Route learning and Transfer." Army Research Institute Technical Report 1022 (Feb 1995), p. 10.

41. Interview with Lieutenant Colonel Kevin Shea, 7 Aug 1995. Lieutenant Colonel Shea, an instructor for the Brigade Tactical Commander' s Development Course at Ft Leavenworth, has postulated the idea that Experience = Confidence = Intuition in trying to explain what a commander must develop to successfully fight on the modern battlefield.

42. Witmer, Bob; Bailey, John & Knerr, Bruce. "Training Dismounted Soldiers in Virtual Environments: Route learning and Transfer." Army Research Institute Technical Report 1022 (Feb 1995), p. 27.

43. Barnaby, Frank. The Automated Battlefield. (New York: The Free Press, Macmillan, Inc, 1986). p. 17.

44. Ibid., p. 18.

45. Interview with Major General Charles K. Heiden (Rtd). His view is that the use of the BCTP, NTC or JRTC opposing forces during the deployment of forces could be much more extensive with current data communications technology.

46. Interview with Major General Charles K. Heiden (Rtd). Part of the automated TOC development centered around providing the ability to provide a large screen IVIS display that would show the movements of units during a battle. No capability provided for the resolution of battle casualties or likely success.

47. Department of the Army, FM 101-5, Command and Control for Commanders and Staff. (Final Draft) (Washington, D.C.: Department of the Army, Aug 1993), p. M-4 to M-9.

48. Cheong, V. E. & Hirscheim, R. A. Local Area Networks. (1983). Although a dated reference this book does cover the basic concept of operating several computers connected and able to interact directly.

49. Software companies already have established the method of modularizing their programs to ease consumer updating of programs later. Offers for upgrades at lower prices and only contain a program to delete old files and insert new ones, keeping the original file names intact.

50. Fort Hood uses the JANUS simulation to aid units training for rotations to the NTC. The Tactical Commander's

Development Course and Battle Command Development Course at Fort Leavenworth offer extensive NTC database scenarios on the JANUS system. For the Advanced Warfighting Experiment in 1994, the digitized task force used the Fort Knox CCTT NTC database for training.

51. Briefing given to the School for Advanced Military Studies on 13 December 1995.

52. Some of these games are: M1 Tank Platoon by Microprose and Wargame Construction Set I & II by Strategic Simulations Inc at the tactical level. At the operational level, an example is Operation Combat II by Merit Software. Finally, the strategic level offerings range from No Greater Glory by Strategic Simulations, Inc, about the American Civil War. While these are neither officially endorsed nor noted for superb accuracy, they represent examples of the gaming tool types available.

53. McClain, Dylan L. "Programmed to Play." The Kansas City Star (15 Oct 1995). p. J-6. Gary Kasparov, a chess master, will play an IBM computer designed specifically to play chess at the master level. At the 1994 annual tournament of humans vs. computers playing chess, computers won 39 percent of the matches. The 1995 tournament has computers predicted to win 50 percent of the matches. "Battle Chess," a computer software program by Interplay is a widely available computer chess program. The program offers three levels of difficulty and learns against an opponent. Though at a crude level to play and defeat most human players, it serves as an example of AI.

54. This modularity is analogous to the Microsoft Windows operating system for IBM computers that accepts programs from other computer software companies. A common communication standard established by Microsoft became widely published and used by software companies. The war game system would accept plug-in modules for terrain, enemy, weather and other variables to tailor the simulation to the unit needs.

55. An example is the Trojan Spirit system. Units frequently bring one of these stations to the NTC and occasionally transmit data from the battles back to the home station, with a return of the analysis back to the unit. While the battlefield information itself at NTC is not classified, the system itself and coding means are classified.

56. This paragraph refers to Chapter 2 and the six general principles set out in FM 101-5 about why rehearsals are useful.

57. A somewhat older generational form of this process is regularly demonstrated by the training rotations at the National Training Center, Fort Irwin, Ca. The After Action Review includes the plan, its execution and statistics gathered by the computer system. This moves by microwave relay to receiving vans positioned through out the military reservation with line of sight to the microwave antenna.

58. The author observed this demonstrated during the first rotation with M1A2s at the National Training Center. A tank platoon leader attached to a non-IVIS equipped mechanized infantry company monitored the task force command net. Hearing his team commander get the order to move and counterattack an enemy breakthrough, the platoon leader gave the order, route and orientation by IVIS to the platoon. The platoon was attacking the enemy flank before the rest of the team could receive the order and begin movement.

BIBLIOGRAPHY

_____. FM 100-5 Operations. (1993).

_____. FM 101-5 Command and Control for Commanders and Staff (Final Draft). (Aug 1993).

_____. TRADOC Pam 525-5 Force XXI Operations. (1 Aug 1994).

_____. Rehearsals. CALL Newsletter No. 91-1 (Apr 1991).

Andrews, Dee H. "Warfighting Training R & D in the Post Cold War Era -- with a Special Emphasis on Synthetic Environments." Educational Technology (Feb 1993): 36-40.

Appleman, Roy E. "Task Force Smith at Osan." U.S. Army in the Korean War; South to the Naktong, North to the Yalu. (Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1961), 65-76.

Barnaby, Frank. The Automated Battlefield. New York: The Free Press, Macmillan, Inc, 1986.

Bartlett, David A. & Curtis, Robert F. "From Virtual MEU to Deployed MEU(SOC)." Marine Corps Gazette (Jul 1994): 26-27.

Burgin, Phil. "Synthetic Settings Boost Skills in Military Training." National Defense (Apr 94, vol. 78, no. 497): 39.

Burnside, B., Quinkert, K., Black, B., Maggart, L. "Design of Mounted Warfare Training for Force XXI." Army RD&A (May-June 1995): 13-14.

Cheong, V. E. & Hirscheim, R.A. Local Area Networks. New York: John Wiley & Sons, 1983.

Clausewitz, Carl von. On War. New York: Alfred A. Knopf, Inc. 1993.

DiMarco, Louis. "Tactics Training in Virtual Reality." Armor (Jan-Feb 1995): 38-40.

Dovey, Michael. "Virtual Reality: Training in the 21st Century." Marine Corps Gazette (Jul 1994): 23-25.

Edwards, O. T. "Digital Battlefield Training and Tactical Insights of a User." Armor (May-June 1995): 12-14.

Hale, S.J. & Williams, M. M.; eds. Managing Change. Washington, D.C.: Urban Institute Press, 1989.

Halpin, Stanley. "Developing Force XXI Battle Commanders." Army RD&A (May-June 1995): 7-9.

Heiden, Charles K. Personal interviews and conversations. July to November 1995.

Heiden, Charles. "Integrating SIMNET Into Heavy Task Force Tactical Training." Army Research Institute Research Product 95-01 (October 1994).

Heiden, Charles. "A Research Study to Determine the Optimal Organizational Structure of the National Training Center's Operations Group." unpublished MA diss., University of Phoenix, 1995.

Hiller, J., Wallace, S., Marcy, S. & Akam, R. "Development of a Force XXI Training Management Strategy." Army RD&A (May-June 1995): 10-12.

Hodges, Kathryn; Dean, David, ed. "Simulation with the Strategic Unconventional Warfare Assessment Model." Low-Intensity Conflict and Modern Technology. Maxwell AFB, Air University Press, 1986: 213-222.

Hoffman, F. G. "Training 2001." Marine Corps Gazette (Jul 1994): 14-18.

Howe, George F. "The Defense of Kasserine Pass, 19 February." and "The Loss of Kasserine Pass." U.S. Army in World War II, Mediterranean Theater of Operations; Northwest Africa: Seizing the Initiative in the West. (Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1957): 447-452 and 453-456, respectively.

Jones, Paul L., ed. Simulation Training, Management Framework Improved, but Challenges Remain. GAO/NSIAD-93-122 (10 May 1993).

Kafkalas, Peter. Low Intensity Conflict and Today's U.S. Army: An Assessment. Harvard University Master of Liberal Arts Thesis. November 1984.

Kitfield, James. "The Promise of Virtual Reality." Government Executive (Feb 1994): 60.

Larijani, L. C.; Machover, Carl, ed. The Virtual Reality Primer. New York: McGraw-Hill, 1994.

Martin, William. "Training in the 21st Century - The Force XXI Training Program." Armor (May-June 1995): 40-41.

McClain, Dylan L. "Programmed to Play." The Kansas City Star (15 Oct 1995): J-6.

O'Byrne, Elton C. "Advanced Distributed Simulation." Marine Corps Gazette (Jul 1994): 18-22.

Pimentel, K. & Teixeira, K. Virtual Reality. New York: Windcrest McGraw-Hill, 1993.

Purkiss, Charles T. "Intelligence Requirements for Low Intensity Conflict." Low-Intensity Conflict and Modern Technology. Maxwell AFB, Air University Press, 1986: 175-189.

Quinkert, Kathleen & Black, Barbara. "Training for Force XXI Technologies." Army RD&A (Nov-Dec 1994): 44-46.

Senge, Peter M. The Fifth Discipline. New York: Doubleday. 1990.

Shea, Kevin. Personal interview. 7 Aug. 1995.

Smith, Richard P.; Dean, David, ed. "War-Gaming and Simulation Support." Low-Intensity Conflict and Modern Technology. Maxwell AFB, Air University Press, 1986: 191-212.

Smith, Roger D. "Virtual Reality Merges with Battle Simulation." Signal (Jul 1993): 52-54.

Viceroy, Joseph A. "Virtual Warfare Captures Mission Rehearsal Task." National Defense (Jan 94, vol. 78, no. 494): 28-29.

Vowels, Lawrence. "Lessons of Operation DESERT HAMMER VI: Material Could Be Improved." Armor (May-June 1995): 15-17, 34.

Wilson, J. R. "Virtual Reality Benefits May Prove Illusory." Interavia/Aerospace World (Apr 1993, vol. 48): 34-35.

Witmer, Bob; Bailey, John & Knerr, Bruce. "Training Dismounted Soldiers in Virtual Environments: Route Learning and Transfer." Army Research Institute Technical Report 1022 (Feb 1995) (ADA 292900).